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Research Article

Complete Atrioventricular Block Following Valve Surgery Under Extracorporeal Circulation in Adults: Incidence and Risk Factors

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Abstract

This single-center retrospective study conducted in Senegal in 2023 aimed to determine the incidence and risk factors of complete atrioventricular block (CAVB) following valve surgery under extracorporeal circulation in adults. Among the 51 included patients, the incidence of postoperative CAVB was high, reaching 19.6%. The study population was young (mean age 36.4 years) and predominantly female, presenting mainly with rheumatic valvulopathies. No statistically significant risk factors were identified, although a trend was observed for prolonged cardiopulmonary bypass and aortic cross-clamp times in patients with CAVB. The majority of blocks (90%) proved to be reversible, recovering either spontaneously or with corticosteroid therapy. Only one patient (10% of CAVB cases) required permanent pacemaker implantation. No deaths were reported. This complication is frequent in this Senegalese context but often transient. The absence of classic risk factors highlights the need for prospective multicenter studies to better identify predictive factors and standardize management protocols in this specific context.

Keywords

Complete Atrioventricular Block, Valvular Surgery, Cardiopulmonary Bypass

1. Introduction

Complete atrioventricular block (AVB) is a serious complication of cardiac surgery under cardiopulmonary bypass (CPB), characterized by a total interruption of electrical conduction between the atria and ventricles [1]. Physiologically, myocardial contraction requires an impulse that propagates through specialized structures of the conduction system. Any disruption of this circuit, whether permanent or intermittent, can lead to severe clinical manifestations ranging from syncope to sudden death in cases of prolonged asystole [2, 3]. Valvular surgery is particularly prone to this risk due to the anatomical proximity between the valvular structures and the atrioventricular node, as well as the bundle of His [4]. The etiologies of valvular heart disease in sub-Saharan Africa are dominated by rheumatic sequelae, affecting a population that is often young [5]. International literature reports a variable incidence of complete AV block, ranging from 1% to 3% after surgery for congenital

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heart disease and up to 23-37% after valve surgery [6]. Given this observation, and with the aim of improving local data, the present study was conducted to determine the incidence and risk factors of this complication following valve surgery under cardiopulmonary bypass in adults.

2. Patients and Methods

This retrospective, single-center, descriptive study was conducted at the Cuomo Cardiac Center (Fann University Hospital, Dakar) during 2023. It included adult patients who underwent valvular surgery under cardiopulmonary bypass (CPB). Data were extracted from medical records and anesthesia records using a standardized data collection form.

The standard protocol included a complete preoperative assessment, mixed intraoperative monitoring (invasive and non-invasive), general anesthesia with antibiotic prophylaxis (cefazolin) and administration of tranexamic acid, as well as immediate postoperative monitoring in intensive care.

The variables analyzed included demographic characteristics, preoperative clinical and paraclinical data (laboratory tests, ECG, echocardiography), and operative parameters (cardiopulmonary bypass and clamping durations, vasopressor support, transfusion). Atrioventricular block (AVB) was diagnosed by ECG in the operating room immediately after aortic declamping.

Statistical analysis was performed using R (v4.2.3). Risk factors were identified using Chi² and t-tests, with a significance threshold set at $p < 0.05$.

3. Results

Of a total of 98 patients who underwent valvular surgery under cardiopulmonary bypass during this period, only 51 (52.04%) were included in our study. The population was young (mean age 36.4 ± 10 years), predominantly female (68.6%), with an obesity rate of 9.8% (BMI > 30 kg/m²). Mitral valve disease was predominant (82.4%), followed by aortic (37.3%) and tricuspid (23.5%) disease. The most frequent procedures were mitral valve replacement (MVR) combined with tricuspid valve repair (31.4%) and isolated MVR (25.5%). Other types of procedures included: MVR + AVR + TVR (13.7%); MVR + AVR (13.7%); isolated AVR (13.7%); and isolated mitral valve repair (2.0%). Cardiovascular risk factors were infrequent: hypertension (9.8%), diabetes (1.96%), and smoking (3.92%). Preoperative ECG revealed left ventricular hypertrophy (LVH) in 33.3% of patients, left atrial hypertrophy in 25.5%, and atrial fibrillation in 19.6%. Echocardiography showed preserved left ventricular function in all patients (mean LVEF 64 ± 6%) and frequent pulmonary hypertension in 20 cases (39.2%), with a mean pulmonary arterial pressure (PASP) of 47 ± 18 mmHg.

During the procedure, anesthetic induction was routinely performed with propofol, combined with midazolam in 98% of cases and/or ketamine in 52.9% of cases. The mean duration of cardiopulmonary bypass (CPB) was 107 ± 43 min and aortic clamping lasted 86 ± 36 min. Vasoactive amines were required in 76.4% of patients, with a transfusion rate of 58.8%.

Ten patients (19.6%) experienced complete AV block at the end of cardiopulmonary bypass (CPB). These patients were characterized by: a mean age of 35.1 years; a female predominance (male/female ratio = 0.6); mitral valve disease in 8 patients; smoking in 2 patients; left heart hypertrophy in 5 patients; a mean LVEF of 66%, a mean pulmonary artery systolic pressure (PASP) of 51.4 mmHg, a mean TAPSE of 24.7 mm; a longer CPB duration (127 ± 35 min vs 102 ± 44 min, p=0.078) and a longer aortic clamping (102 ± 32 min vs 82 ± 37 min, p=0.118). No other sociodemographic, echocardiographic or valvular disease-related factors were significantly associated with AV block, although a marginal association was noted with smoking (p=0.035), interpreted with caution given the small sample size (2 smoking patients, both with AV block).

Postoperatively, among the 10 cases of AV block, 2 patients experienced spontaneous remission before admission to the intensive care unit, and the others (8 patients) received corticosteroid therapy (methylprednisolone 2 mg/kg/day), resulting in complete recovery in 7 of them. Thus, only one patient (10% of those with AV block) required implantation of a permanent pacemaker on day 15. No deaths were recorded in our series, and the average length of stay in the intensive care unit was 4 ± 2 days.

4. Discussion

This retrospective, single-center study, conducted at the Cuomo Cardiac Center in Dakar, aimed to determine the incidence and risk factors of complete atrioventricular block (AVB) after valve surgery with cardiopulmonary bypass (CPB). Although its retrospective nature resulted in the absence of certain clinical and paraclinical data, thus limiting the scope of some analyses, it nevertheless offers valuable insights in a context where local data are scarce.

From an epidemiological standpoint, the mean age of our population was 36.4 ± 10 years, significantly lower than that observed in Western studies, where it often exceeds 60 years [7-9]. This difference is explained by the predominance of valvular heart disease of rheumatic origin in our region, unlike the more frequent degenerative etiologies in developed countries [10]. Furthermore, we noted a female predominance (male/female ratio = 0.7), consistent with the results of Florian et al. [11], but contrary to the series by Igor et al. [9] and Andres et al. [7], where men were in the majority.

Regarding diagnoses, mitral valve disease was the most frequent (82.4%), followed by aortic (37.3%) and tricuspid (23.5%) valve disease. This profile is consistent with that reported by Sahar et al. [12], but differs from that of Andres et al. [7], where aortic valve disease predominated. Furthermore,

only 20% of our patients presented with at least one cardiovascular risk factor, a proportion much lower than that observed by Pierre [13] and Sahar [12], where more than half of the patients were affected.

The preoperative examination revealed dyspnea in 15.3% of patients and signs of heart failure in 3.9%. These figures were lower than those reported by Andres [7] and Beatriz [8], likely due to optimized preoperative cardiological management. Paraclinical findings on ECG revealed left ventricular hypertrophy in 33.3% of cases and left atrial hypertrophy in 25.5%, reflecting the hemodynamic impact of the valvular heart disease. The preoperative incidence of complete tachyarrhythmia due to atrial fibrillation was 19.6%, comparable to the data reported by Sahar [12]. Preoperative echocardiography showed a very high incidence of pulmonary arterial hypertension, at 90%. This rate was higher than that reported in Kim's study [1] (62%).

Intraoperative management was characterized by systematic intravenous induction, often with co-induction (propofol, midazolam, ketamine), allowing for reduced doses and adverse effects. Anesthetic maintenance frequently combined sevoflurane and propofol, although sevoflurane is recognized for its superiority in myocardial protection [14]. The variability of protocols reflects the lack of standardization, with choices tailored to each patient. The mean duration of cardiopulmonary bypass (107 min) and aortic clamping (86 min) was shorter than that reported by Sahar et al. [12]. The frequent use of sympathomimetics (76.4%) and transfusions (58.8%) is explained by the hemorrhagic potential of this type of surgery and the hemostasis alterations induced by cardiopulmonary bypass [15].

In the postoperative period, only 9.8% of patients were extubated in the operating room, and the average time to extubation in the intensive care unit was six hours. Although early extubation may reduce mechanical ventilation-related complications [16], it exposes the patient to risks of hypoventilation, thus justifying an individualized approach.

The incidence of complete AV block in our series was 19.6%, a figure close to the 23% reported by Sahar et al. [12]. The majority of these blocks were transient: two patients recovered spontaneously, seven with corticosteroid therapy, and only one required a permanent pacemaker. Reversible causes, such as post-surgical edema or inflammation, are well documented [7], while direct damage to the conduction tissue more often leads to permanent blocks [2, 3]. The anatomical proximity between the valvular structures and the conduction system explains the occurrence of these disorders, particularly during mitral valve replacement [17, 18]. The optimal timing for pacemaker implantation remains a subject of debate; in our study, it was performed on day 15, whereas Ben Ameur [19] reports an average of 31.8 days.

In multivariate analysis, no significant risk factors were identified, although smoking showed an association ($p = 0.035$) that was not considered significant due to the small sample size. Contrary to Andres et al. [7], who showed that age > 60 years and mitral valve disease were predictive factors, our series did not confirm these links. Similarly, the duration of cardiopulmonary bypass and aortic clamping, although longer in patients with atrioventricular block, was not significantly associated with the occurrence of blocks, contrary to the observations of Andrzej and Beatriz [8, 20]. These discrepancies may be explained by the small size of our sample and the younger profile of our population.

5. Conclusion

In Senegal, complete atrioventricular block (AVB) complicates nearly 20% of valvular surgeries performed under cardiopulmonary bypass. Although it is mostly transient and resolves with medical treatment, this complication remains serious due to the risk of requiring a permanent pacemaker. Contrary to data in the literature, no significant risk factors were identified in our series, which was characterized by a young and predominantly female population. Prospective multicenter studies are essential to refine the identification of predictive factors and optimize perioperative management protocols.

Abbreviations

AVB	Atrioventricular Block
CAB	Complete Atricularoventricular Block
CPB	Cardiopulmonary Bypass
BMI	Body Mass Index
MVR	Mitral Valve Replacement
AVR	Aortic Valve Replacement
TVR	Tricuspid Valve Repair
LVH	Left Ventricular Hypertrophy
LVEF	Left Ventricular Ejection Fraction
PASP	Pulmonary Arterial Systolic Pressure
TAPSE	Tricuspid Annular Plane Systolic Excursion

Author Contributions

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Conflicts of Interest

The authors declare no conflicts of interest.

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